SURVEY REPORT

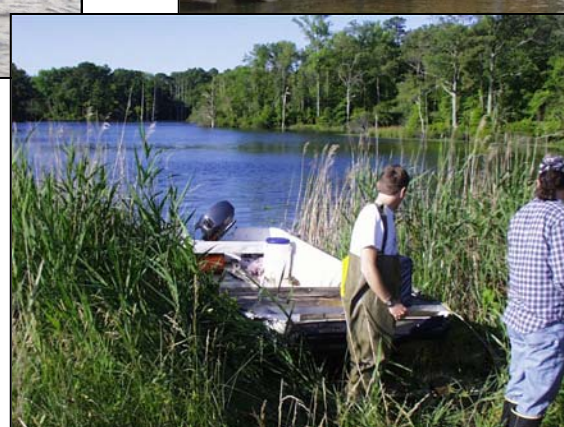
2003 GEOPHYSICAL SURVEY OF THE JAMES RIVER BEACHFRONT,

TCC LAKE AND J LAKE

AT THE

FORMER NANSEMOND ORDNANCE DEPOT

FINAL
MAY 2004



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1. INTRODUCTION

Geophysical surveys of the James River Beachfront (JRB), TCC Lake and J Lake areas at the Former Nansemond Ordnance Depot (FNOD) were conducted from May 31st to June 5th, 2003 to characterize the nature and extent of debris remaining from historical depot operations. These surveys fulfill Phase I of the Environmental Characterization study, as described in the project Work Plan (SAIC, 2003). The surveys employed a marine magnetometer (mag) and submersible electromagnetic metal detector (EM) to detect metal debris, a sub-bottom seismic profiler to identify metal and non-metal debris and geologic features at depth, and an echosounder to measure water depth. This report presents a synopsis of survey activities (Section 2), an assessment of data quality (Section 3), preliminary results for the JRB presented as debris maps (Section 4) and finally suggested locations for Phase II sediment coring at the JRB based on debris maps and erosion modeling (Section 5).

2. SURVEY SYNOPSIS

The survey vessel, a 25’ aluminum outboard-powered tri-hull, was mobilized at Bennett’s Creek Marina in Suffolk, VA on May 30th. On May 31st, the mag (Geometrics G-881) and bathymetry (Odom Hydrotrac) surveys were conducted concurrently over the wide survey area at the JRB. The raft-mounted sensors were towed 30’ behind the survey vessel (Photo 1) to eliminate vessel interference. Per the Work Plan, both data types were captured and merged with DGPS by Hypack® survey software. On shore along Shore Road, a magnetometer base station was set up to record fluctuations in the earth’s magnetic field every 60 seconds during the survey, so that the survey readings (collected 10 times per second) could be diurnally corrected during processing (see Section 3).

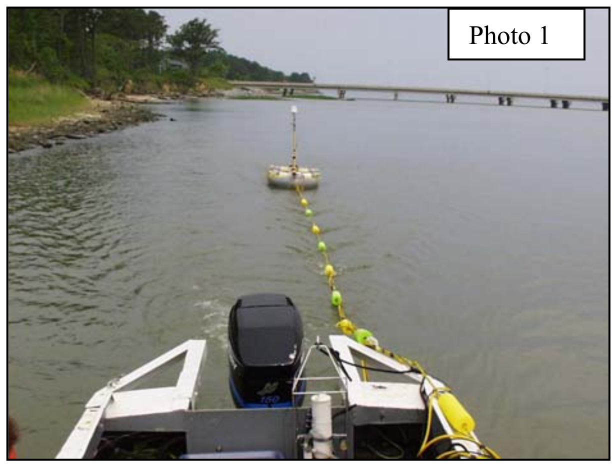

Photo 1

At the beginning of each survey day, two magnetometer tests were conducted. For the “Static Test”, mag data was logged in a presumed “clean” (i.e., free of metal) area for one minute to verify the stability of instrument readings. For the “Target Line” test, a metal target (Target #1, a 24.5 lb steel cylinder used in the Prove Out detection confirmation test) was deployed seaward of the JRB area and then surveyed to ensure the instrument was responsive. These tests were also conducted with the EM on days when that instrument was used.

During the survey, the shallow draft of the tri-hulled survey vessel and high tide conditions permitted access to most of the survey lines proposed in the Work Plan, except for those intersecting land or in very shallow water (~< 1 ft). At the beginning and end of the day, CTD casts were taken to obtain speed of sound measurements required for processing of the bathymetric measurements. On June 1st, 20-25 knot winds produced sea conditions that were too rough for collection of quality data at the JRB. Accordingly, the sheltered TCC Lake was surveyed with mag and bathymetry (Photo 2). As use of the JRB survey vessel was not feasible on the small lake, a smaller 19' outboard-powered skiff was launched from the lake's bank. A new target (Target #11, from the Prove Out) was deployed for the Target Line test. The lake was successfully surveyed during the course of the day with good data coverage obtained. However, the limited maneuverability of the towed raft containing the sensors made positioning on the 25'-spaced survey lines proposed in the Work Plan difficult to achieve. Despite heavy tree cover, DGPS signal integrity was maintained. In the real-time mag data stream, several pronounced responses were observed when surveying the northern end of the lake (the westernmost of which appeared to correspond to a water level gauge). A number of focused survey lines were run in this area to clearly define the location of the target(s).


Photo 2

On June 2nd, Static and Line Tests indicated good EM (Geonics EM-61S MKII) performance on TCC Lake, so the survey was conducted. The EM was "nulled" (response adjusted to 0 mV in a clean area) prior to the static test and periodically during the survey day. Similar to the mag survey, a sizable EM response was observed at the northern end of the Lake, so additional lines were surveyed in that area. After the survey, the 19' vessel was hauled and re-launched in J-Lake.


Photo 3

On June 3rd, a second survey team was employed so that surveying could continue at both the JRB and lakes simultaneously. One team conducted the mag and bathymetry survey of J-Lake (Photo 3). The mag performed well, but abundant aquatic vegetation frequently fouled the bathymetry transducer. Despite frequent cleanings, a number of no-data points were observed in the dataset. However, coverage of the remaining data appeared sufficient.

The second team mobilized the EM and sub-bottom profiler (Benthos/Datasonics ChirpII) aboard the JRB survey vessel. The instruments were mounted in tandem rafts to ensure collection of spatially collocated data (Photo 4). While EM and sub-bottom data streams appeared good, the sub-bottom PC's operating system crashed upon attempting to record the data. Various diagnostic remedies (disabling the navigation string, re-installing the ChirpII software, etc.) were ineffective. Finally, it was determined that insufficient monitor resolution was causing the crashes in record mode. The situation was corrected in time for surveys the following day.

On June 4th, the EM survey of J-Lake was performed. However, Static and Target Line tests performed on this lake revealed considerable environmental noise. Connectors, cables and power supplies were checked and replaced as appropriate, but the source of noise could not be identified and hence appeared to be environmental in nature. The survey was conducted knowing that anomalies generating a response less than ~30 mV would be masked by the noise (See Section 3). After completing the J-Lake survey, the EM was transferred to the JRB vessel for continuance of the EM and sub-bottom survey of the wide area. EM and sub-bottom data were successfully collected over much of the wide and focused areas. The survey team maximized accessibility to the shallowest survey lines by alternating between the two areas as appropriate for the tide stage.

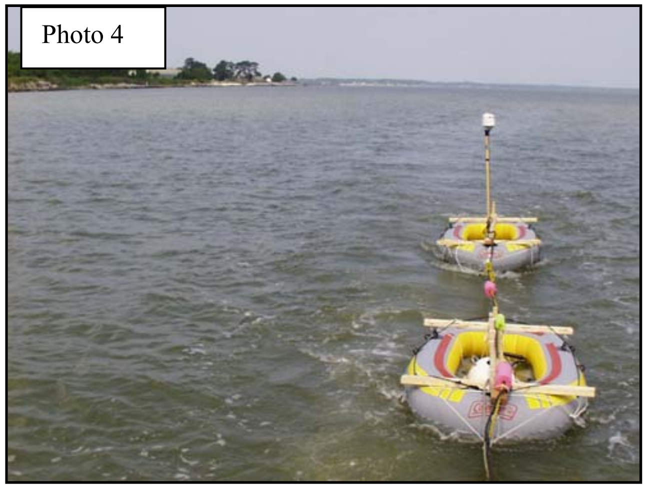
Photo 4

On June 5th, the EM and sub-bottom survey of the JRB wide and focus areas was completed. Occasional noise was observed in the EM data, and sub-bottom signal returns were generally faint. Hardware gain and display threshold had to be greatly increased over the previous day's settings. Numerous diagnostic attempts (cleaning the contacts, checking the cable, reloading the software, etc.) were made to improve the sub-bottom return.

While sub-bottom data was successfully collected at the JRB, vessel size limitations imposed by the lack of a boat ramp on the Lakes prevented sub-bottom surveying in the Lakes. Also, it is unlikely that the sub-bottom signal would have been able to pentrate the gas bubbles in the lake sediment, which were observed upon disturbance of the bottom (gassy sediments are impenetrable by the low frequency sound waves).

Otherwise, good data coverage was obtained during the surveys for all survey areas and data types. At the JRB, bathymetry, mag, EM and sub-bottom data were obtained along the nine 6,000' survey lines comprising the wide survey area as proposed in the Work Plan (SAIC, 2003). Additionally, EM and sub-bottom data were collected in the JRB focus areas, which comprised the nearshore area from the I-664 bridge west to the TCC Lake culvert. This area was selected based on the considerable number of targets identified by the wide survey. Data were collected along high-density survey lines (e.g., approximate 10' spacing) in the focus area. For TCC and J Lake, the survey lines proposed in the Work Plan were followed when possible, although the irregular shapes of the lakes and numerous obstructions (e.g., stumps) necessitated adjustment of many lines. Still, sufficient data coverage was achieved, as line spacing approximated the 25' increment proposed in the Work Plan and additional lines were surveyed along the lakes' shorelines. As for the JRB, additional focused lines were surveyed in areas where targets were identified by the wide survey.

3. DATA PROCESSING AND QUALITY

Survey data were processed generally following procedures proposed in the Work Plan. Processing details and assessments of data quality are presented in the following subsections, along with a brief description of erosion modeling procedures.

3.1. BATHYMETRY

For preprocessing, the bathymetric data was reviewed and subjected to standard processing routines in Hypack, including deletion of “spikes” and corrections for water column sound velocity. For the JRB data, water level data from the Sewells Pt. VA tide station was obtained from the NOAA Ocean and Lakes Levels Division (OLLD) web-server (http://opsd.nos.noaa.gov/), adjusted using time offsets for Pig Point, and applied to the bathymetric data from the survey region to correct for water level variations due to tides. The NOAA station provides water level readings at 6 minute intervals referenced to the vertical datum of Mean Lower Low Water (MLLW). Data from the Lakes was not adjusted to a vertical datum as these water bodies are non-tidal.

For spatial processing, the JRB data set was subsequently interpolated to produce a continuous surface using kriging techniques in ArcInfo supplied by Geographic Information System (GIS) software (Version 8.3, ESRI 2003). Given the 75’ lane spacing and range of observed depths, a 50’ grid cell size was determined to optimally represent the bottom features of the JRB. For the lakes, a 3’ grid cell size was used to provide sufficient resolution for the relatively small areas. The grid extents were clipped to the survey boundaries for each area.

As stated in Section 2, some difficulty was encountered in collecting the bathymetry data in J-Lake. Abundant surface and subsurface aquatic vegetation caused frequent fouling of the transducer. Also, the soft leaf-litter bottom did not present a strong acoustic signature in the paper depth trace. These factors resulted in numerous “spikes” and “dropouts” in the dataset. In half of the survey lines, these features were removed by deletion and subsequent interpolation during processing, but in the remaining lines, dropouts were often ubiquitous and resulted in “no data” for the entire line.

3.2. CESIUM MAGNETOMETER

For preprocessing, the raw data from the survey mag were exported from the Hypack data acquisition software and imported into Geometrics’ MagMap 2000 software. Each file (one per day) was plotted as a profile and reviewed. The “Remove Dropouts” utility in MagMap was used to automatically cull the few “no-data” points from the dataset. The profiles were reviewed for spikes, but none were identified that would be representative of instrument noise (e.g., a spike >100 nanoTesla (nT) measured in <10 consecutive readings according to MagMap manual). Data from the mag base station were also imported into MagMap in order to diurnally correct the survey mag data (survey mag reading – base mag reading). In this process, MagMap subtracts the base station readings from the coincident survey mag readings based on time, such that the resulting values represent magnetic field (in nT) above the earth’s ambient magnetic field.

The goal of spatial data processing was to select high priority locations for sediment coring by comparing targets identified by mag, EM and sub-bottom sensors. First, a trackline map (indicating data coverage at the site) of the diurnally-corrected mag data was produced. The map for the JRB indicated that, in general, readings east of the I-664 bridge were substantially lower than those west of the bridge, apparently an artifact of the large dipolar magnetic influence of the bridge. This artifact appeared to mask targets on the east side of the bridge (e.g., the sewer pipe identified in the 2000 Offshore Survey). Accordingly, the data for all survey areas were re-mapped with UX-Detect, a magnetics processing module that operates on Geosoft's Oasis Montaj platform (version 5.0 used). UX-Detect is designed to provide enhanced interpretation of the dipole response characteristic of magnetic targets. It uses Total Field (in nT) data to generate an Analytic Signal Grid of the gradient of magnetic response (in nT/ft). Targets were then selected from the grid generated from the JRB mag data using UX-Detect's Blakely Algorithm, set to automatically select grid cell size, and using a default target type of "Type 2 = Pipe". The target picking threshold was increased until only the highest-response targets (approximately 100) at the JRB were retained (threshold = >70 nT/ft). For the lakes, magnetic data were gridded in the same manner, but target selection was not necessary as the targets are readily apparent.

3.3. ELECTROMAGNETIC METAL DETECTOR (EM)

For EM data preprocessing, the data files were displayed in Geonics' DAT61MK2 software, with profile plots of signal response along each survey line compared to responses observed during the Static and Line Tests for that day. During the Static Tests, instrument noise typically ranged from approximately +1.5 mV to –1.5 mV, and hence was deemed an acceptable level of noise in the survey data. Actual noise observed during passage through clean areas was similar.

Overall, quality of the EM data was good. For most of the dataset, proportionate responses were observed across all four time gates (measurements taken at set intervals after an electromagnetic pulse is generated), with anomalies represented as well-defined peaks in profile plots. In areas containing no metal, instrument response was consistently at or near zero millivolts, with little or no drift in this baseline. Lines containing responses that were above zero but were consistent and thus indicative of local background were re-nulled (using the "Shift Data" and "Remove Background" functions in DAT61MK2) so that background again approximated zero. As expected, the earlier time gates (Gates 1 and 2) were noisiest throughout the dataset, as they are measured immediately after the instrument pulses. The last time gate (Gate 4) was relatively quiet, but tended to mute response of lower magnitude anomalies. Gate 3 gave the best compromise between noise reduction and sensitivity, and hence was the focus of processing.

Occasionally, isolated portions of the dataset exhibited considerable noise, as identified by disagreement between instrument channels and lack of a well-defined baseline response in areas free of metal. The magnitude of the noise appeared to vary between the survey areas in a manner allowing a noise threshold to be established for each survey area. In each case, the threshold was determined by reviewing the survey area data and determining what minimum response (in mV) the dataset could be baselined to (i.e., removing noisy readings and erroneous spikes), while balancing the objective to delete noise above the threshold yet maintain sufficient sensitivity to detect targets.

Data collected from TCC Lake was relatively noise-free, and hence this threshold was set at 2 mV. As such, erroneous readings (e.g., records with poor gate agreement, spikes comprised of only 1 or 2 readings) exceeding 2 mV were deleted from the TCC dataset. The JRB data, by comparison, was more variable likely due to the presence of metal and the bridge, such that a noise threshold of 5 mV was selected as the baseline. For J-Lake, considerable environmental noise was observed (see Section 3.1), requiring a baseline of 30 mV. The result is a record with cleaner depiction of true targets, but anomalies producing responses below their respective thresholds could not be discerned.

In most files, noise was pervasive during only a few seconds of data collection, and thus deletion had little effect on data coverage. In a few cases, noise was prevalent throughout several entire survey lines, which were deleted from the dataset. Data gaps resulting from these deletions were minimized because much of the JRB survey area was surveyed twice with the EM and hence adequate replacement data was often available.

As previously discussed, a track line plot of baselined response was prepared and reviewed for spatial processing. As for the mag data, targets were not easily discerned so the data was plotted as a grid in UX-Detect. Again, the measured response was screened to obtain the 108 highest response targets (>130 mV) in the JRB area.

3.4. Sub-bottom Seismic Profiling

For preprocessing, the sub-bottom profile data were reviewed using Isis (Triton Elics) software. The location of discrete subsurface reflectors indicating potential debris/targets were digitized. In total, 96 buried or partially buried targets were identified in the JRB sub-bottom records. During spatial processing, these targets were plotted along with targets identified by mag and EM.

3.5. Erosion Modeling

Three storm scenarios were modeled to estimate the potential for sediment erosion along the JRB, and hence exposure of buried debris. The storm scenarios modeled were: 1) 100-year flood; 2) hurricane storm surge; and 3) 100-year wind storm. A combination of three numerical models was used to predict seabed elevation changes: hydrodynamics, wind wave and sediment transport. Site-specific data were used to develop model inputs and specify storm forcing functions, e.g., freshwater inflow, tidal elevation and wind speed/direction. The model assumed a stable shoreline, and hence did not account for introduction of terrestrial material from bluff erosion.

For spatial processing, model results from the scenario producing the most erosion (100-year wind storm; maximum scour = 2.3’) were mapped and overlaid on sub-bottom targets. A comparison of target depth to erosion depth was made. The 100-year wind storm scenario generated the highest bottom shear stresses and hence produces the most sediment movement (QEA, 2003).

4. PRELIMINARY RESULTS AND JRB CORE LOCATION RECOMMENDATIONS

4.1. RESULTS FOR JAMES RIVER BEACHFRONT

Mapped results confirm the presence of debris along the JRB shoreline, where historical disposal operations and ongoing shoreline erosion are known to have occurred (SAIC, 2002). Areas of apparent sediment deposition visible in the collected bathymetry data correlate well with areas of substantial bluff erosion (Figure 1). These areas correspond with numerous magnetic targets located just west of the I-664 bridge (Figure 2), the area of most concentrated debris. While a number of targets appear to correspond to the I-664 bridge, targets and debris have been observed immediately adjacent to the bridge and may be present under the bridge, hence the bridge area was not excluded from target selection. The sewer pipeline just east of the bridge is clearly visible, as was the case in the 2000 mag data (SAIC, 2002). Several other linear features, apparently cables, are visible east of the sewer pipe. These targets were generally confirmed by the EM data (Figure 3), although nearshore targets generated stronger relative returns than were apparent in the mag data. This artifact is likely the result of EM data collection within the focused area, where greater data coverage was achieved close to shore and hence closer to targets.

The mag and EM target maps were reviewed for candidate areas for sediment coring. Some high-magnitude magnetic targets along the shoreline were not selected for coring as they corresponded with outfalls and other non-debris related features observed during the survey (Figure 4). Sub-bottom targets were also concentrated in the bridge area, but were also observed fairly regularly to the west along the shoreline (Figure 5). The likelihood of exposure of buried sub-bottom targets was considered, but was deemed unlikely for all targets based on erosion model results (Figure 6).

Areas of both net erosion and deposition were predicted within the study area as a result of the simulated extreme wind event (Figure 6). During the event, high shear stress on the bottom would cause erosion over most of the study area. The resulting resuspended sediment would be transported by tidal currents, and then redeposited as winds subsided. As a result, areas receiving little sediment would experience net erosion, while other areas would have net deposition. Presently, onshore soil erosion to the nearshore area is providing additional “cap” material on top of the existing sediment/debris in the nearshore zone. Presumably, this upland erosion activity will be eventually stabilized. Hence, over the long-term it is the areas of predicted erosion that are of concern and this will be the primary focus for coring.

Of all targets identified by the various data types, a subset were identified by two or more datatypes (within a 20’ radius), and were carried forward to Figure 7. Again, the majority of the targets were in the nearshore area just west of the bridge. It was these target clusters that were assumed to represent the most prominent debris and hence potential for chemical contamination, and thus were the focus of core location selection. Accordingly, ten core locations were selected according to the rationale presented in Table 1. Most locations possess targets identified by all three data types (mag, EM, sub-bottom) and are in erosional areas according to the erosion model results. Alignment with historical shorelines provided further evidence for appropriateness of some locations. Two locations, JRB-4 and JRB-9, lacked prominent magnetic debris, but were selected as the presence of sub-bottom target indicates a potential subsurface layer that could be associated with chemical contamination. Targets evaluated but not selected for coring are discussed in Table 2.

As the selected core locations target areas of greatest metallic and non-metallic debris, the resultant analytical data proposed for the Phase II (chemistry/toxicity testing) should adequately characterize worst-case exposure conditions at the JRB. Evaluation of these data in the proposed screening ecological risk assessment should provide a conservative assessment as to the presence of actionable risk at the site.

Uncertainty regarding the appropriateness of the core locations exists due to significant shoreline erosion from Hurricane Isabel, which occurred three months after this survey. A visual inspection of the FNOD shoreline conducted October 9th, 2003 revealed considerable loss of shoreline (up to approximately 100') along the James River beachfront, with lower magnitude losses along the Nansemond River beachfront (SAIC, 2003b, in prep). In some areas, the erosion unearthed additional metal debris buried along the shoreline. Several empty 170-mm artillery shells were among the debris uncovered in front of Tidewater Community College Beazly building, along the JRB (Harry Wheeler, pers. Comm.). In areas of greatest erosion (adjacent to the I-664 bridge), eroded sand and soil appeared to have been deposited in large fans in the nearshore area. Hence, the potential for transport of unearthed terrestrial contaminants into the nearshore area exists. Thus, the suitability of proposed coring locations for characterize post-storm contaminant distribution may require confirmation with a post-storm debris survey.

4.2. RESULTS FOR TCC LAKE

Water depths in the main body of TCC Lake are fairly consistent, generally ranging from 3 to 4 ft, and up to 5 ft deep in isolated areas (Figure 8). In the southern end of the lake, near the feeder creek, depths are somewhat shallower, ranging from 2 to 3 ft. Isolated shallow areas amidst deeper areas, which could suggest placement of fill material or debris, are not evident. However, mag and EM results do indicate the presence of large metal objects/debris clustered in several areas in the lake (Figure 9). The most prominent of these is along the northern shore of the lake, where a cluster of targets with moderate magnetic (~7.2 nT/ft) and electromagnetic (~5.5 mV) responses is evident. Detection by mag indicates the metal is ferrous. A portion of the magnetic responses may be attributable to re-bar or other steel associated with the concrete spillway in this area, although the target cluster extends away from shore and thus likely represents debris. The second largest target is located at the southern end of the lake, along the shoreline, and again was confirmed by both mag and EM. In the remainder of the lake a number of small, isolated targets were identified by mag. The EM target along the eastern shore of the lake is likely associated with the test target placed in that area. In summary, several large magnetic targets in the lake have been confirmed by both mag and EM, and are likely debris.

4.3. RESULTS FOR J-LAKE

Water depths in the body of J-Lake generally range from 4 to 7 ft, with an isolated 10 ft deep hole along the northern shore of the lake (Figure 10). In the lower third of the lake, a shallow area (3-4') located between two deeper areas (7') along the shoreline may be associated with filling activity. This shallow area contains a cluster of magnetic targets (up to 7nT/ft) and is adjacent to a building visible in the airphoto, and could be related to disposal activities. During the survey this area was probed with a PVC pipe, and a hard object was detected at the sediment surface, although poor water clarity and vegetation prohibited visual inspection. The EM also confirmed a target in this area (~62 mV) which exceeded the moderate level of noise in the dataset (discussed previously). A number of other magnetic targets are evident throughout the lake. While two of these targets may be attributable to outfalls observed along the shoreline (Figure 10, photo insets), the remainder could not be ascribed to structural features and thus may represent debris.

5. REFERENCES

QEA (Quantitative Environmental Analysis, LLC). 2003. Sediment Stability Analysis to Support FNOD Beachfront Study. Prepared under contract to SAIC. September.

SAIC. 2002. Final Report: Findings of an Environmental Survey of the Marine Offshore Areas of the Former Nansemond Ordnance Depot, Suffolk, VA. Prepared for U.S. Army Corps of Engineers-Norfolk District. September.

SAIC. 2003. Final Work Plan for Environmental Characterization of the James River Beachfront Nearshore Area at the Former Nansemond Ordnance Depot, Suffolk, VA. Prepared for U.S. Army Corps of Engineers – Norfolk District under contract DACA65-99-D-0068, DO 38. May.

Figure 1. Shoreline bathymetry along the FNOD James River Beachfront, May 2003.

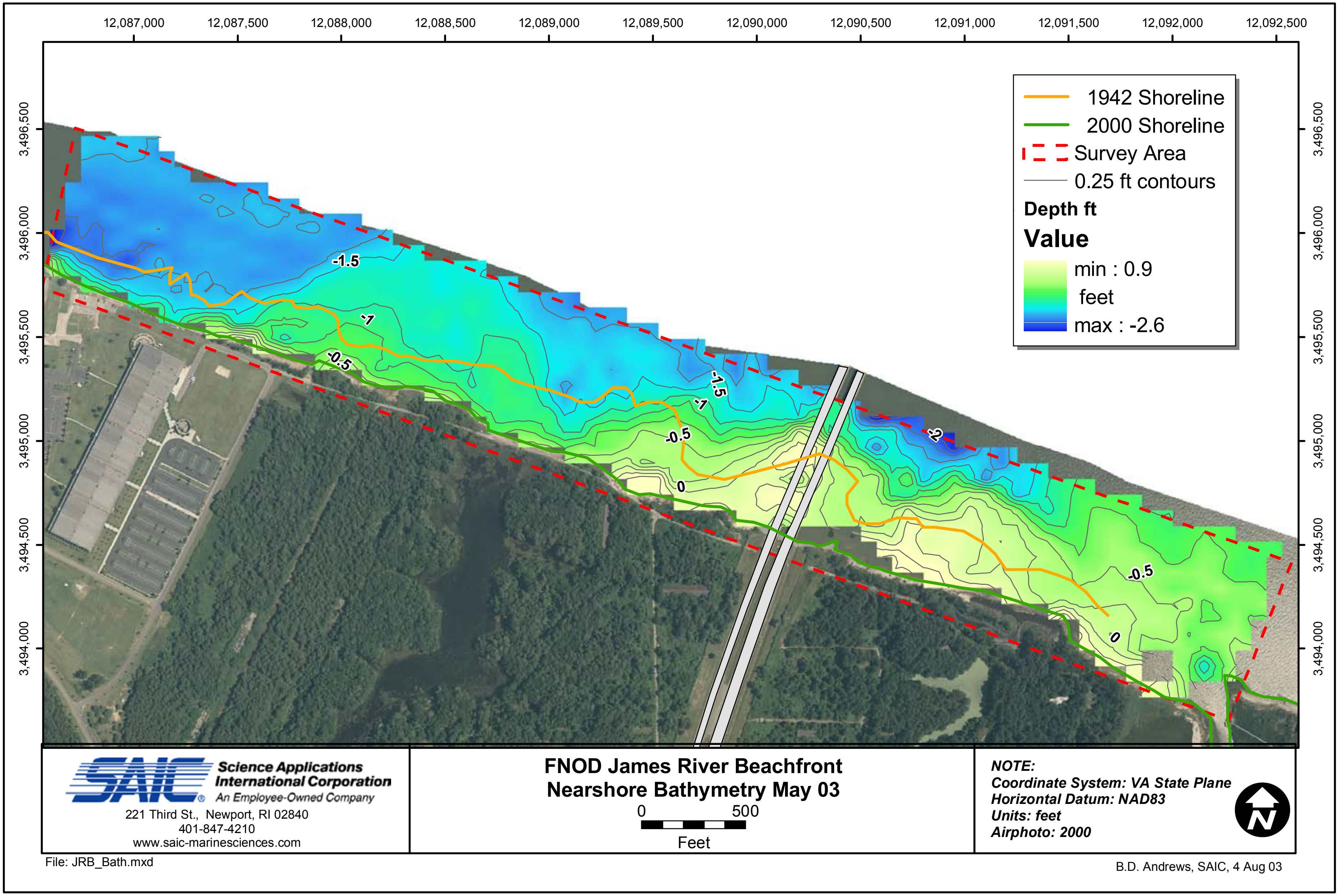

Figure 2. Targets identified in magnetometer data collected along the FNOD James River Beachfront, June 2003.

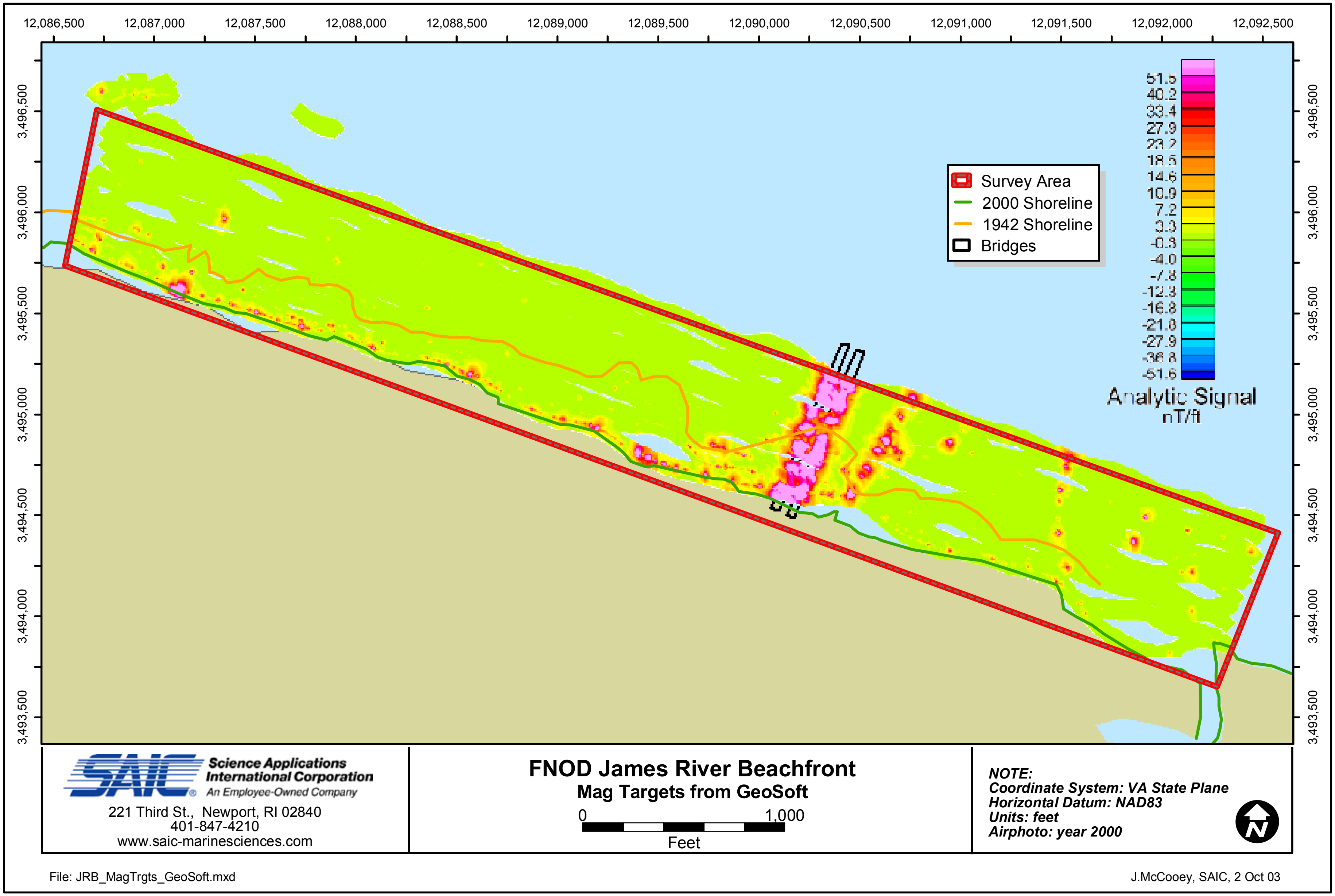

Figure 3. Targets identified in electromagnetic (EM) data collected along the FNOD James River Beachfront, June 2003.

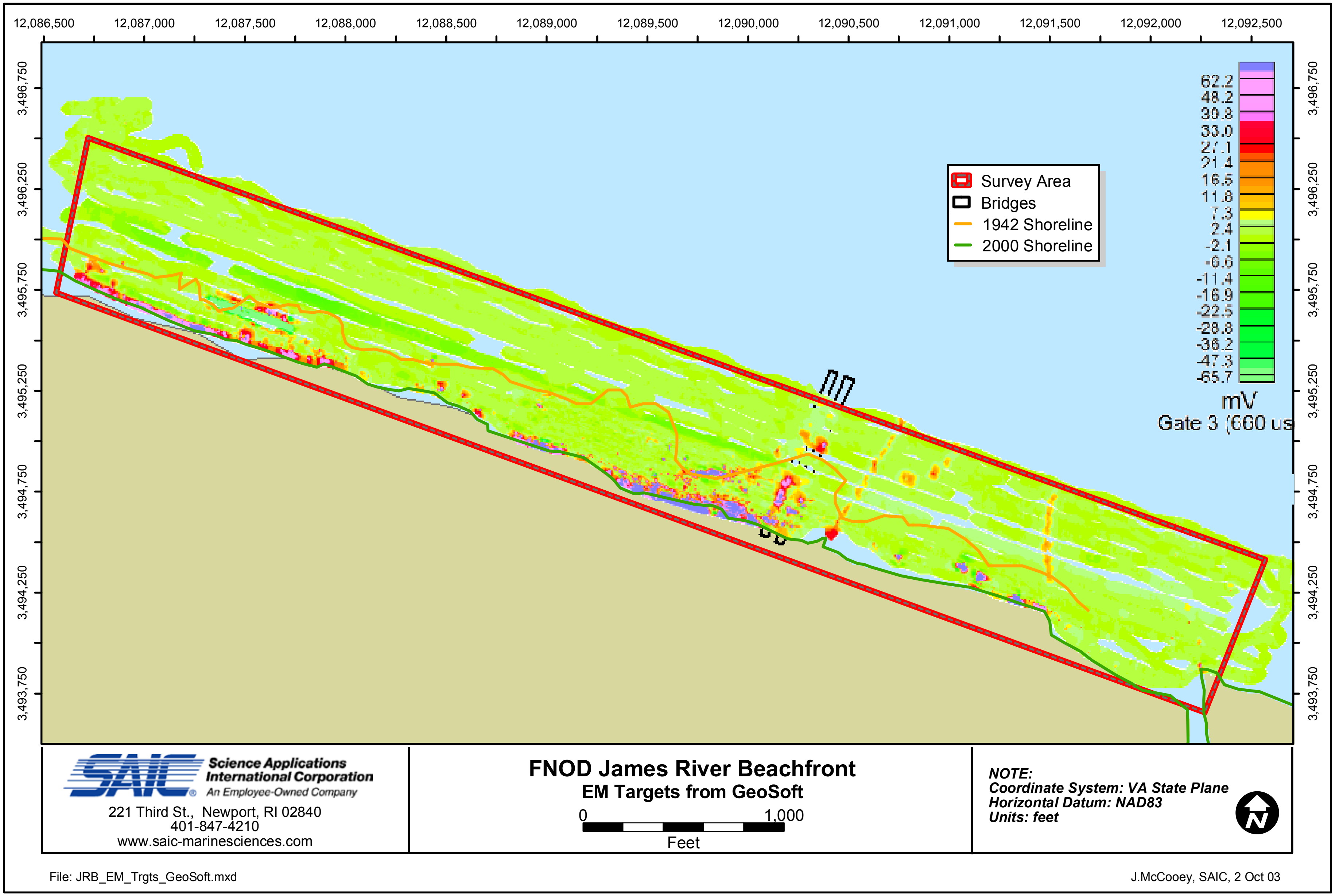

Figure 4. Location of non-debris related features observed along the FNOD James River Beachfront.

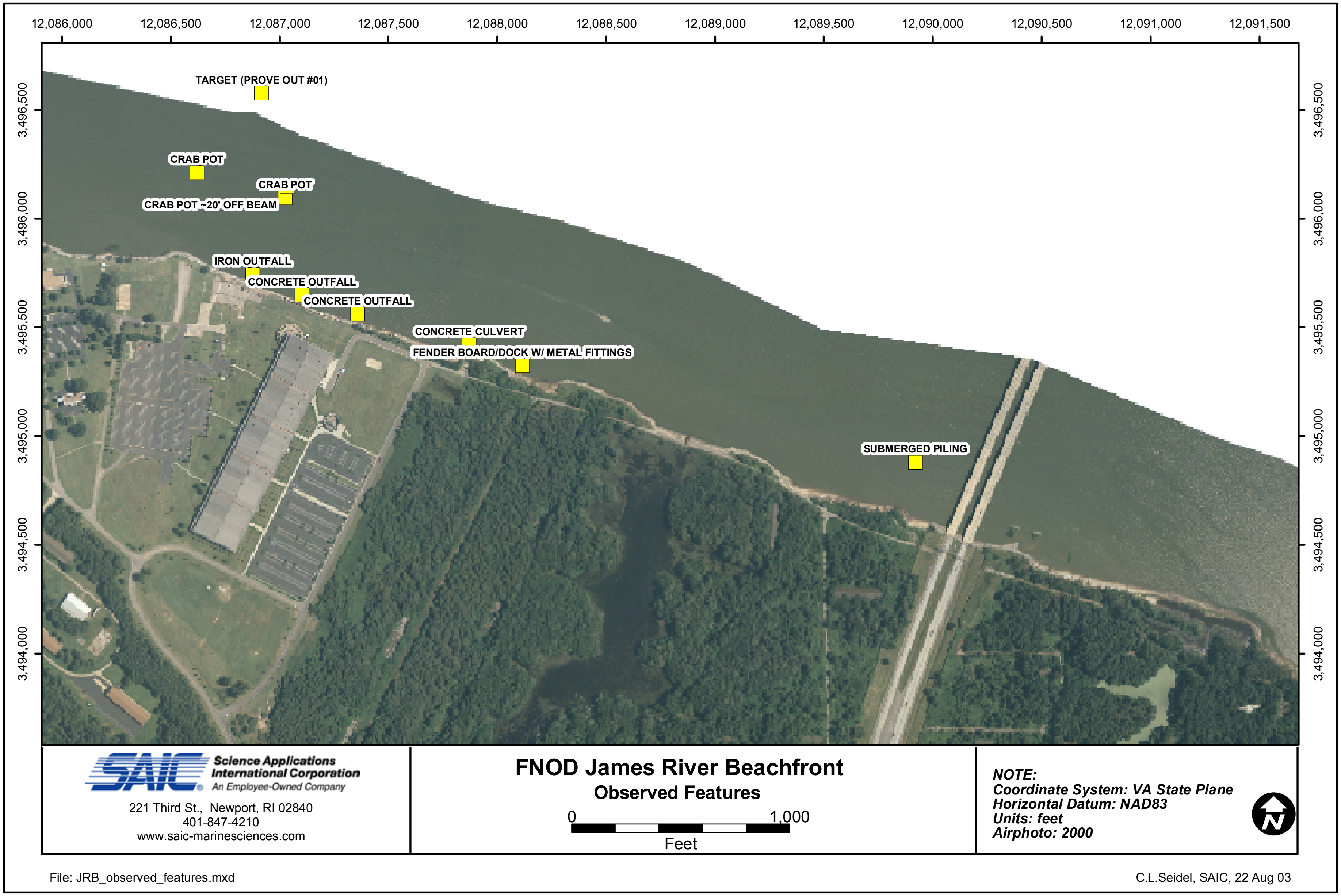

Figure 5. Targets identified in sub-bottom data collected along the FNOD James River Beachfront, June 2003.

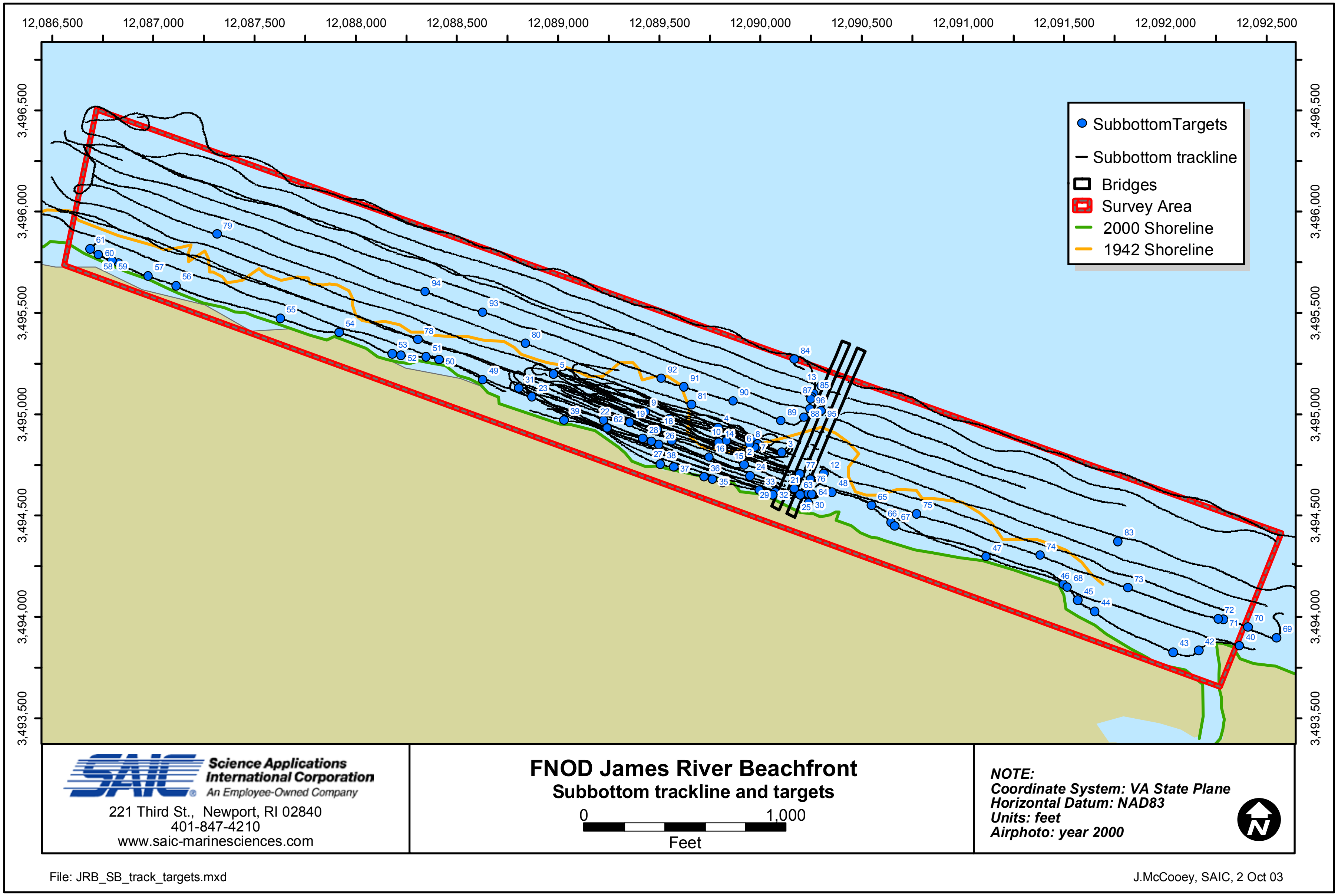

Figure 6. Comparison of depths of sub-bottom targets (confirmed by magnetometer or EM) to modeled seabed elevation change from 100-year wind storm.

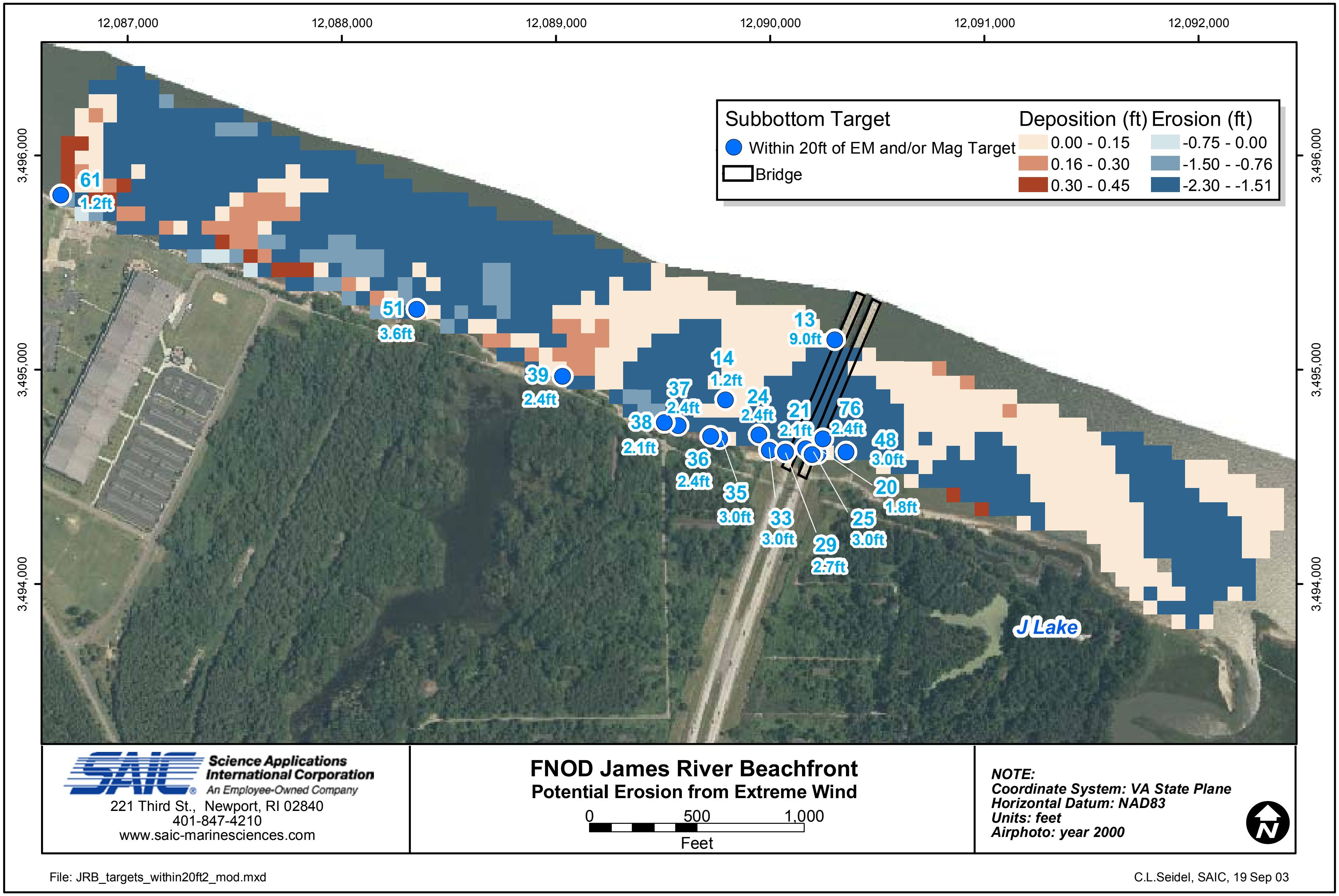

Figure 7. Selection of coring locations based on targets identified in two or more data types (magnetometer, electromagnetic, sub-bottom) at the FNOD James River Beachfront.

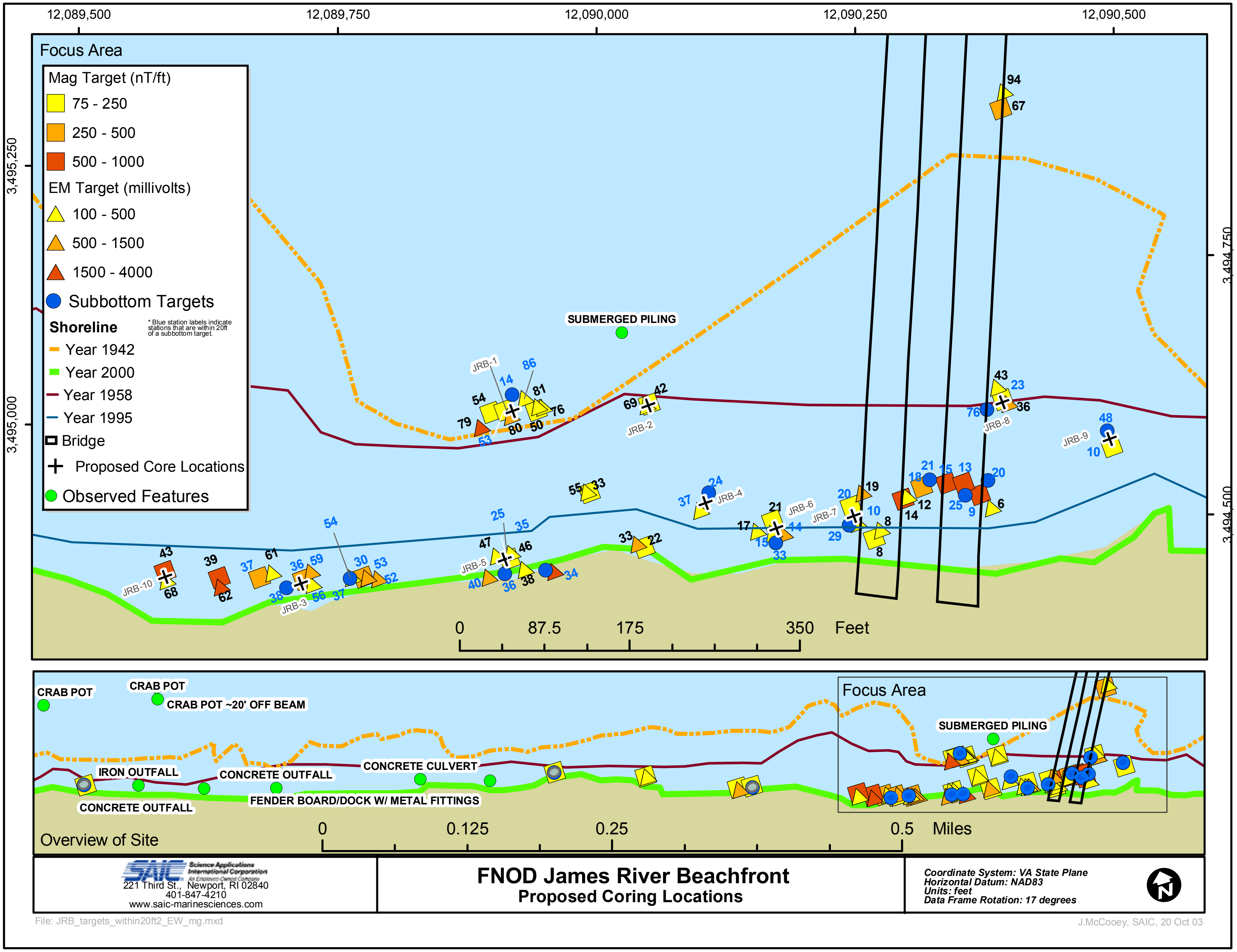

Figure 8. Bathymetry of the TCC Lake at FNOD, June 2003.

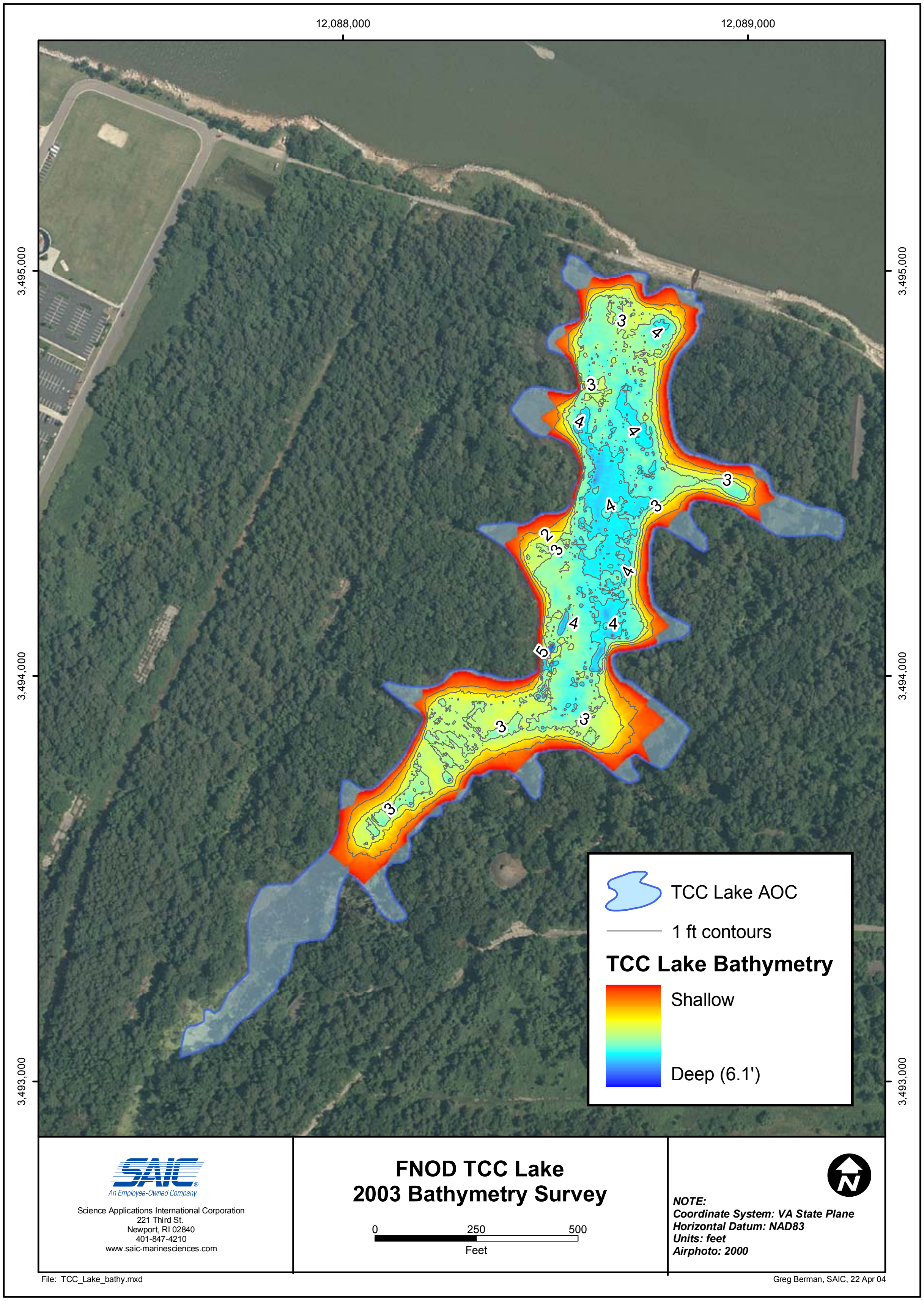

Figure 9. Targets identified in magnetometer and electromagnetic data collected from the TCC Lake at FNOD, June 2003.

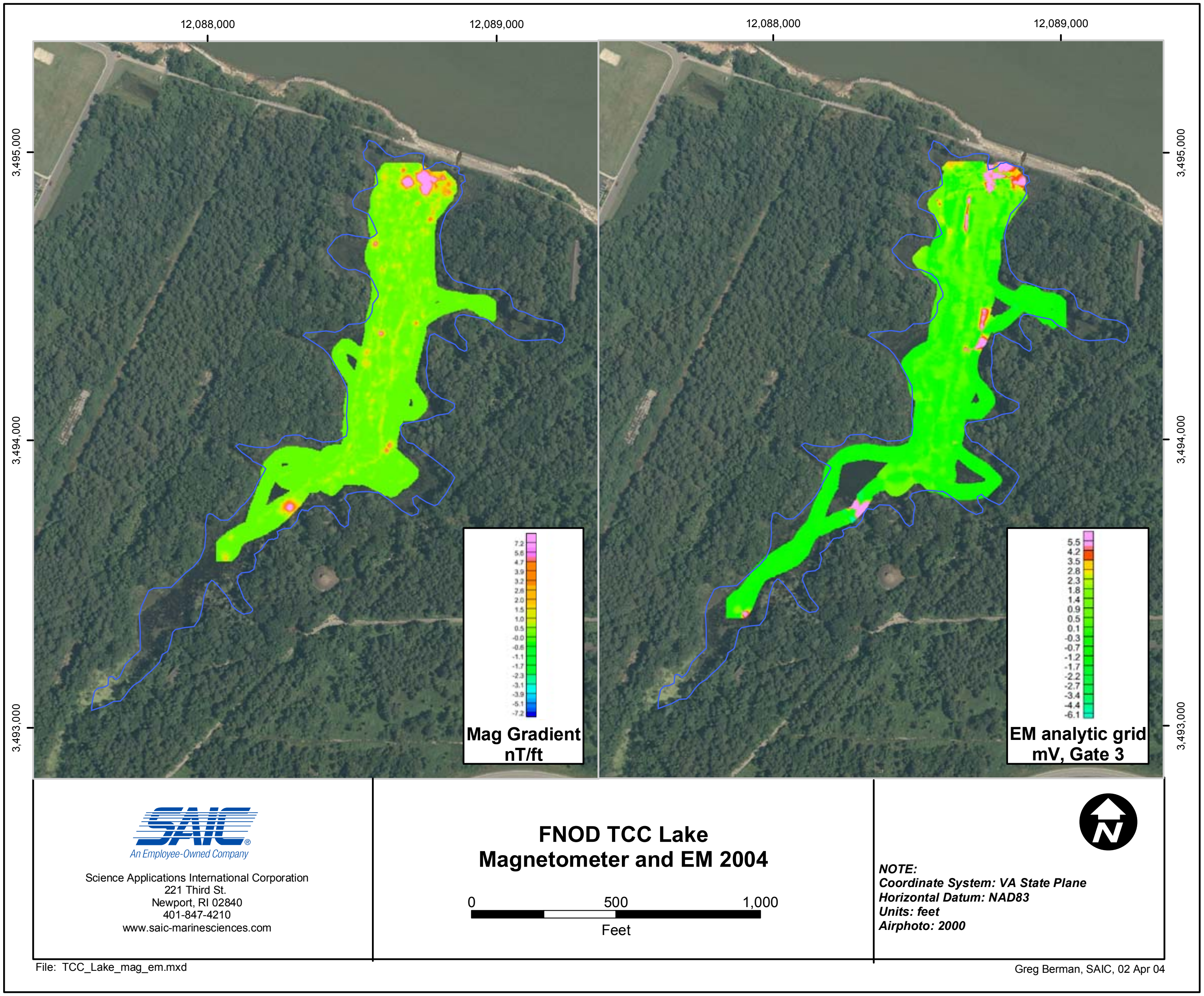

Figure 10. Bathymetry of J Lake at FNOD, June 2003.

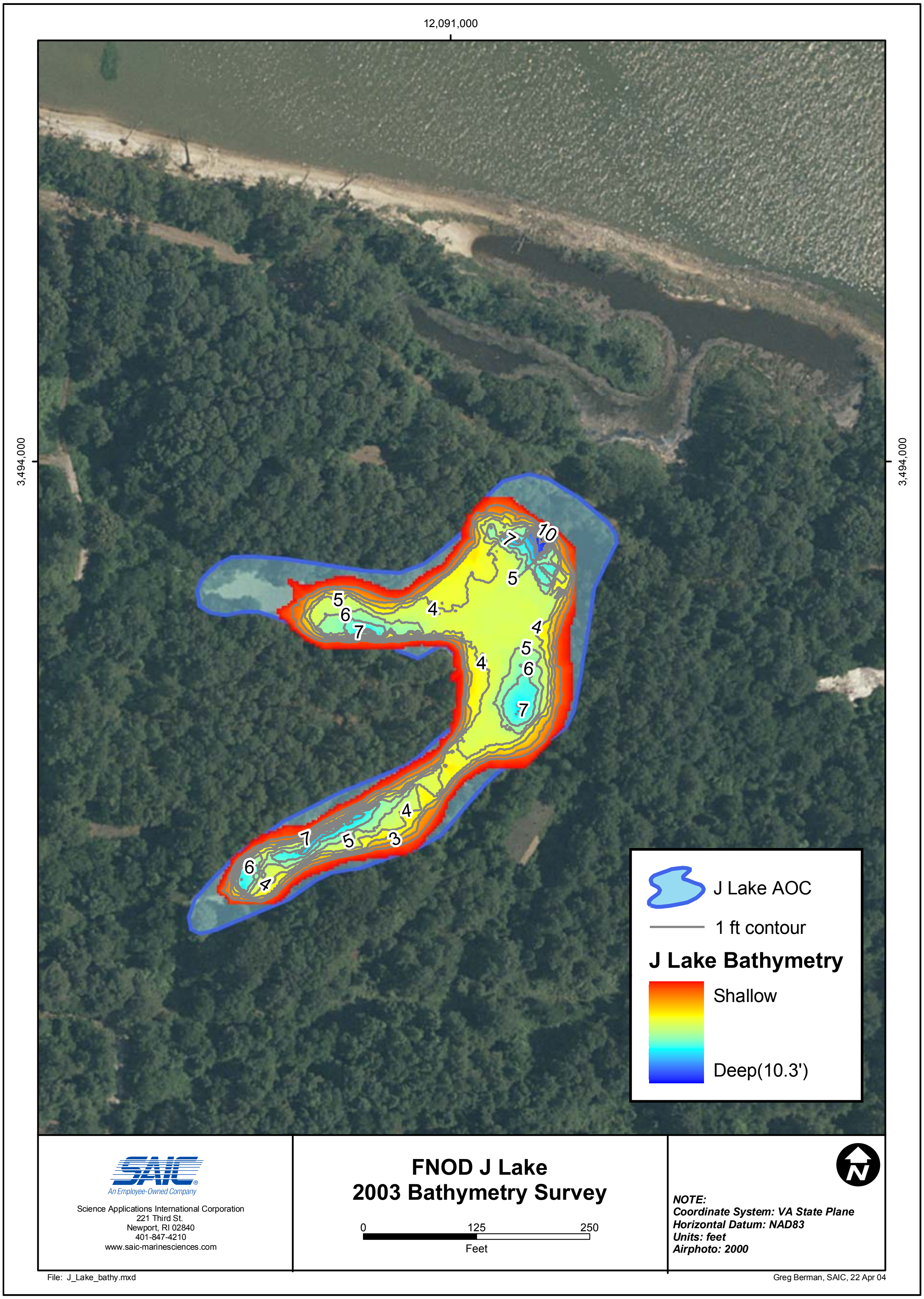

Figure 11. Targets identified in magnetometer and electromagnetic data collected from J Lake at FNOD, June 2003.

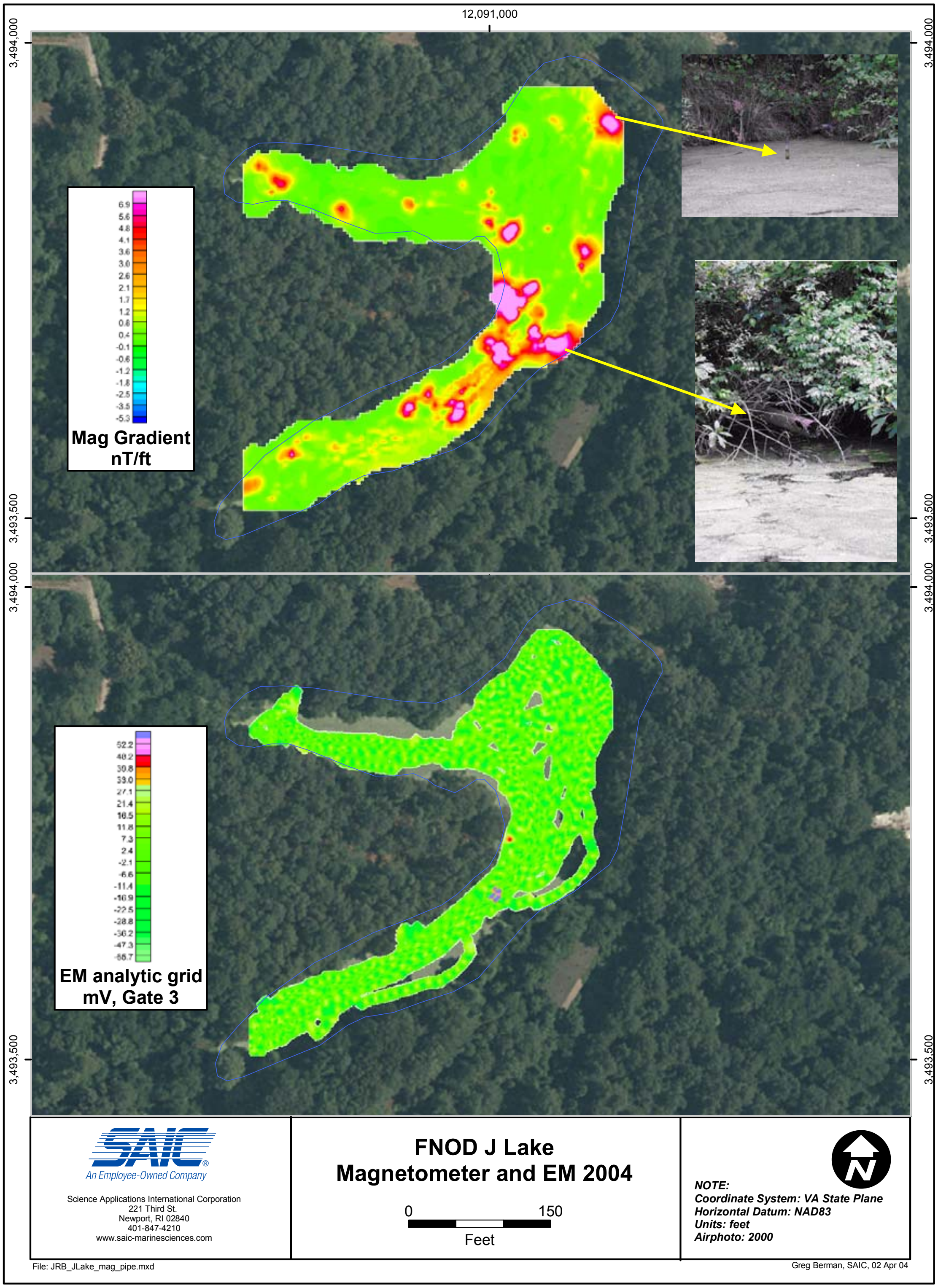

Table 1. Rationale for selection of sediment coring locations at the FNOD James River Beachfront.

Core Location	Target identified by Magnetometer (Mag)	Electomagnetic (EM)	Sub-bottom (Sub)	Target Depth < Erosion Depth[1]	Sediment Stability[2]	Comment	Ordnance/Risk Potential
JRB-1	√	√	√		-	Ferrous metal debris, subsurface, erosional area, along 1942, 1958 shorelines	Moderate
JRB-2	√	√		ind	-	Ferrous metal debris, erosional area, along 1958 shoreline	Moderate
JRB-3	√	√	√	√	0	Ferrous metal debris, subsurface, erosional area, erosion potential, along 2000 shoreline	Moderate
JRB-4		√	√		-	No mag hit, low EM hit, but sub indicates potential subsurface layer, erosional area	Moderate
JRB-5	√	√	√		-	Ferrous metal debris, subsurface, erosional area, along 2000 shoreline	Moderate
JRB-6	√	√	√		-	Ferrous metal debris, subsurface, erosional area, along 1995 shoreline	Moderate
JRB-7	√	√	√		-	Ferrous metal debris, subsurface, erosional area, along 1995 shoreline	Moderate
JRB-8	√	√	√		-	Ferrous metal debris, subsurface, erosional area, along 1958 shoreline	Moderate
JRB-9	√		√		-	Low mag hit, noEM hit, but sub indicates potential subsurface layer, erosional area	Moderate
JRB-10	√	√		ind	-	Ferrous metal debris, likely at/near surface, erosion potential	Moderate

1 - "ind" = target depth not available from sub-bottom

2 - Sediment stability modeling indicates: "+" = depositional area; "-" = erosional area; "0" = stable (+/- 0.75 ft)

Table 2. Targets not selected for sediment coring at the FNOD James River Beachfront.

Target[1]	Target identified by Magnetometer (Mag)	Electomagnetic (EM)	Sub-bottom (Sub)	Erosion Potential?[2]	Comment
E62	√	√		ind	Not identified by sub-bottom; proximal to other selected core location
M37	√	√		ind	Not identified by sub-bottom; proximal to other selected core location
M42	√	√		ind	Not identified by sub-bottom; low magnitude mag, EM response
M22	√	√		ind	Not identified by sub-bottom; not confirmed by other targets
S21	√	√	√	√	Associated with bridge
S22	√	√	√	√	Associated with bridge
S20	√	√	√	√	Associated with bridge

1 - "M" = magnetic target, "E" = electromagnetic target, "S" = sub-bottom target.

2 - "ind" = indeterminate erosion potential as target depth not available from sub-bottom